Hemispheric ENSO Cycling and Lake Michigan Coastal Dune Evolution:

A Relationship?

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Michigan State University

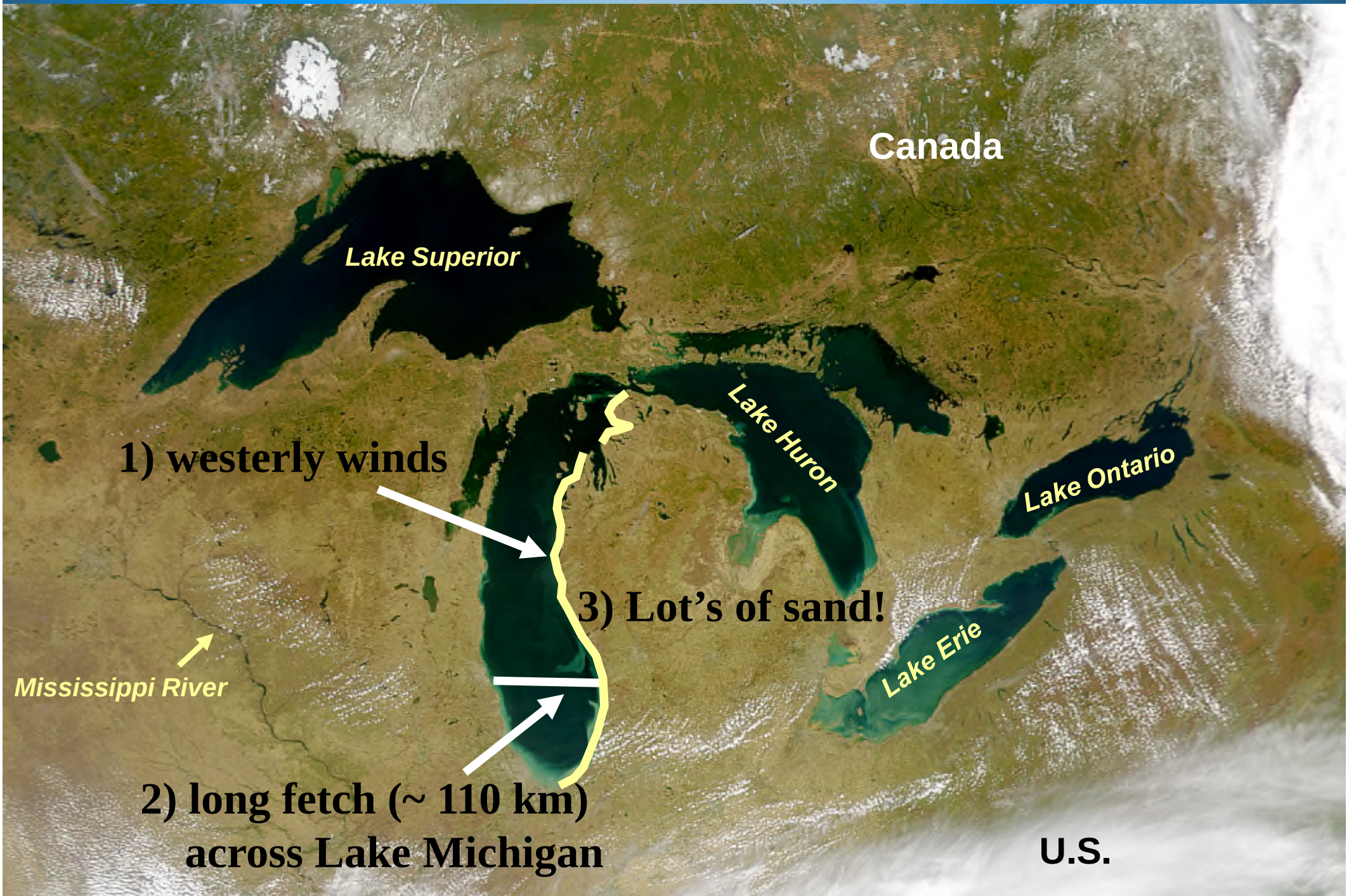

South Africa


Australia


New Zealand


England

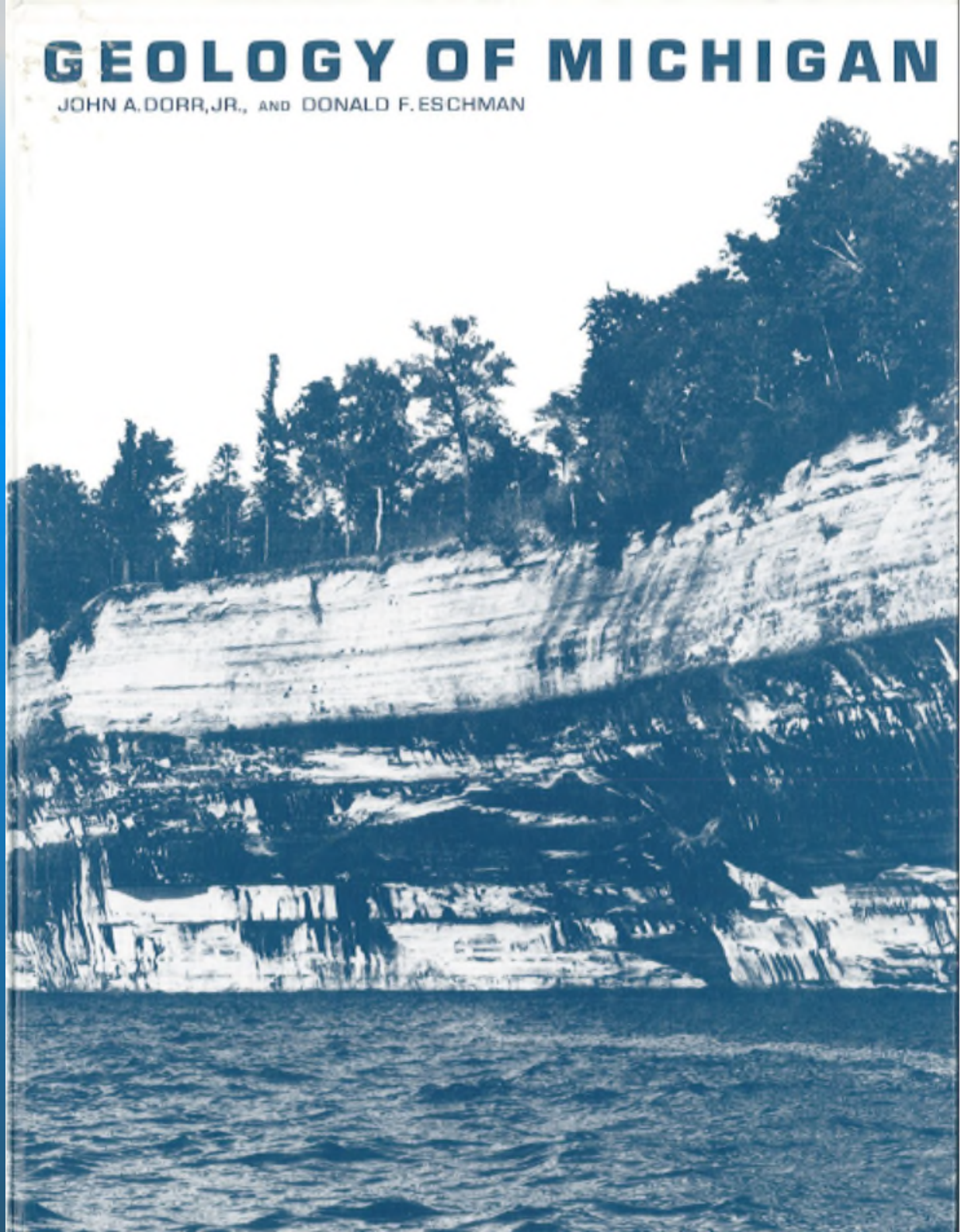
America's North Coast

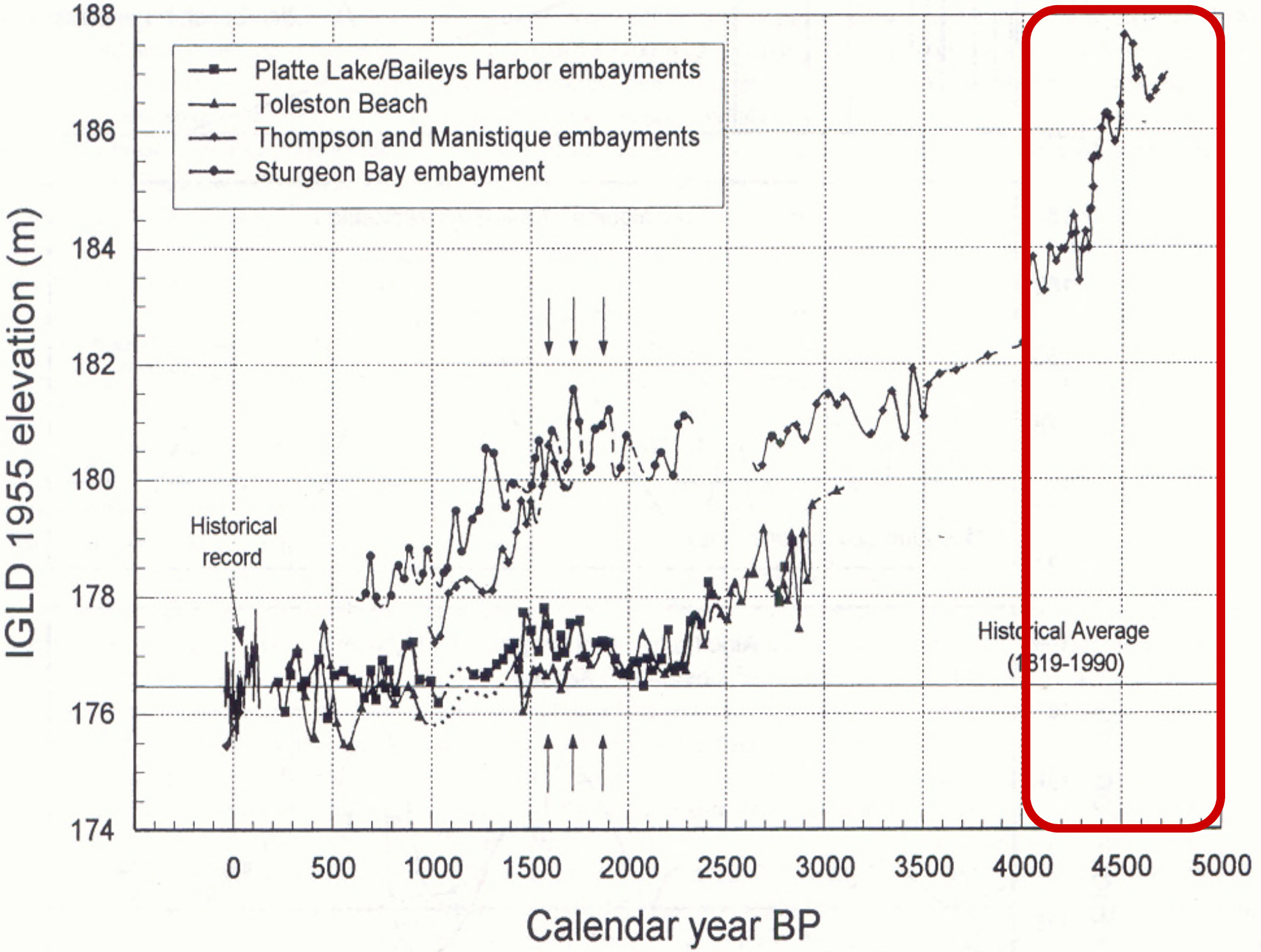


Nipissing Dunes

Formed in a Single Continuous Event

But No Dates!!




Platte Lake/Baileys Harbor embayments
Toleston Beach
Thompson and Manistique embayments
Sturgeon Bay embayment
Historical record
Historical Average (1819-1990)
IGLD 1955 elevation (m)
Calendar year BP
188
186
184
182
180
178
176
174
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000

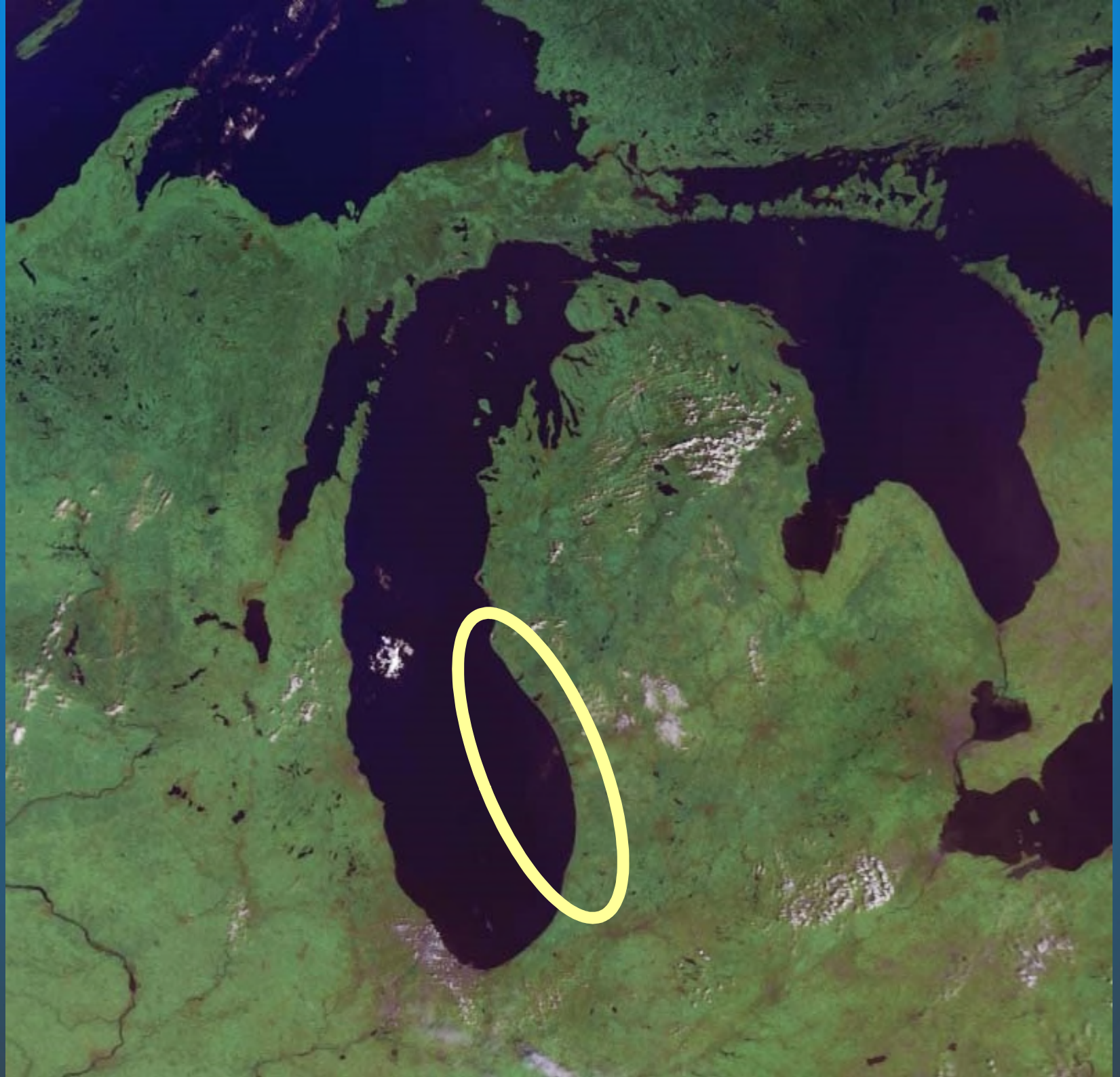
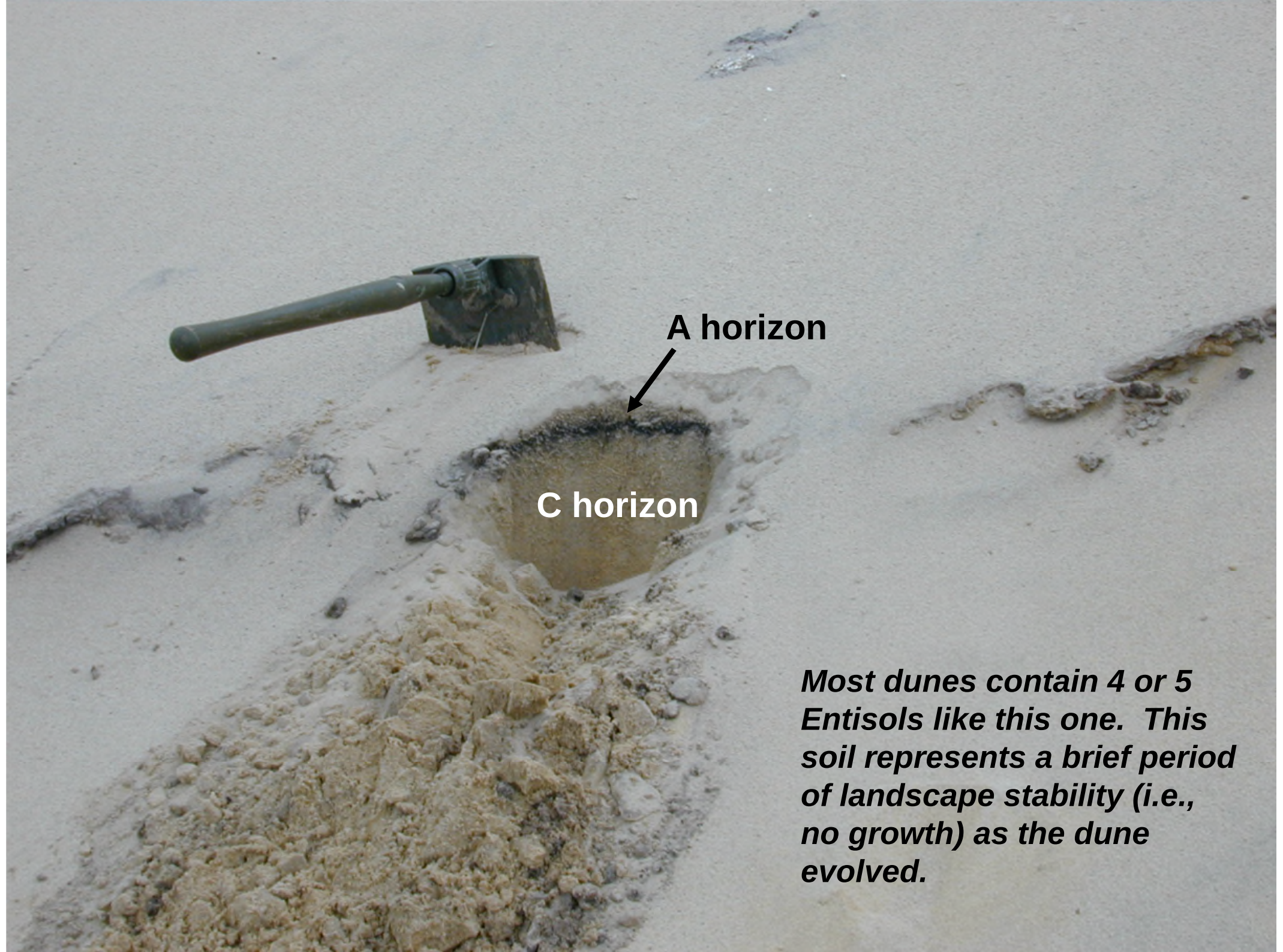
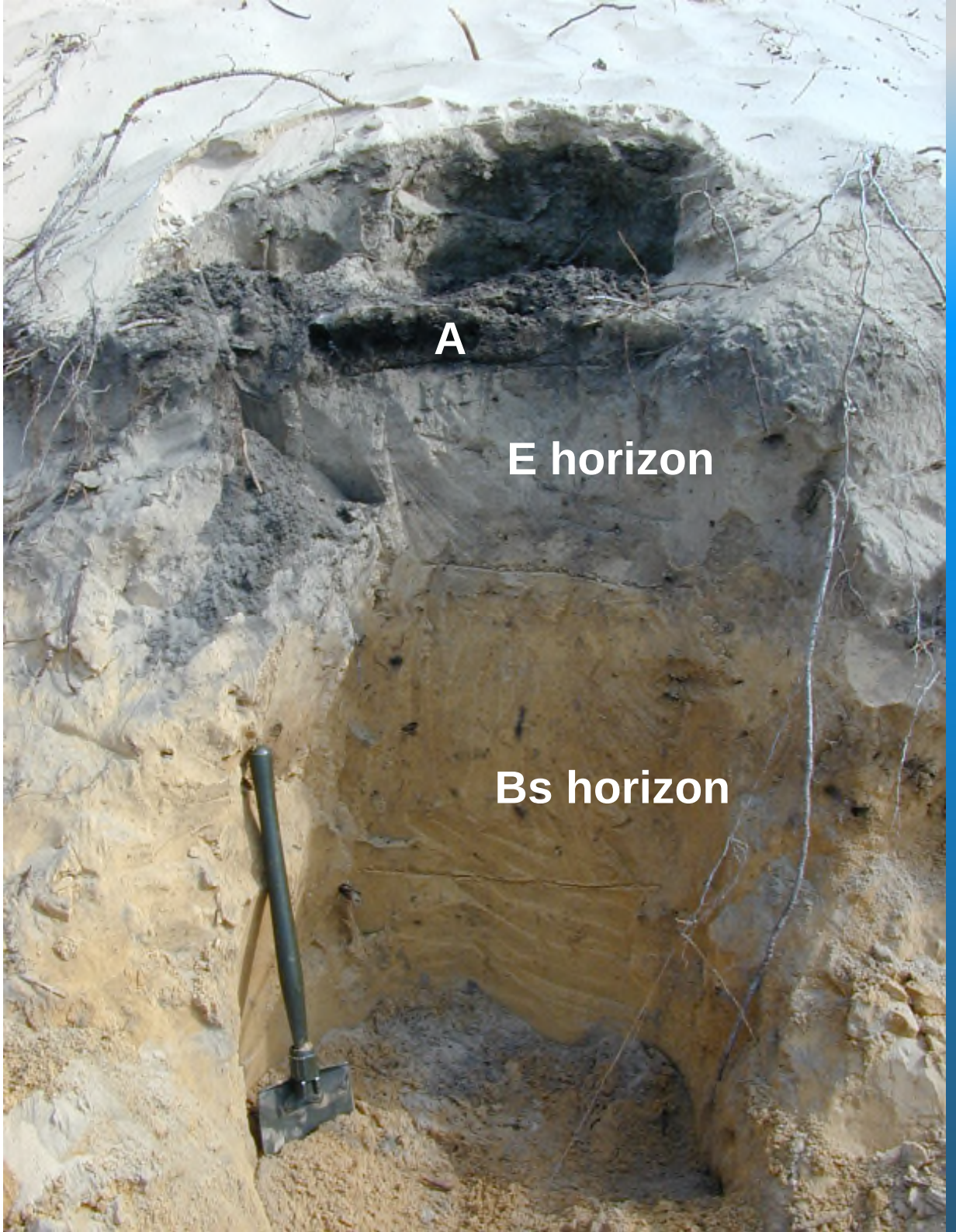


Photo: Ed Hanson

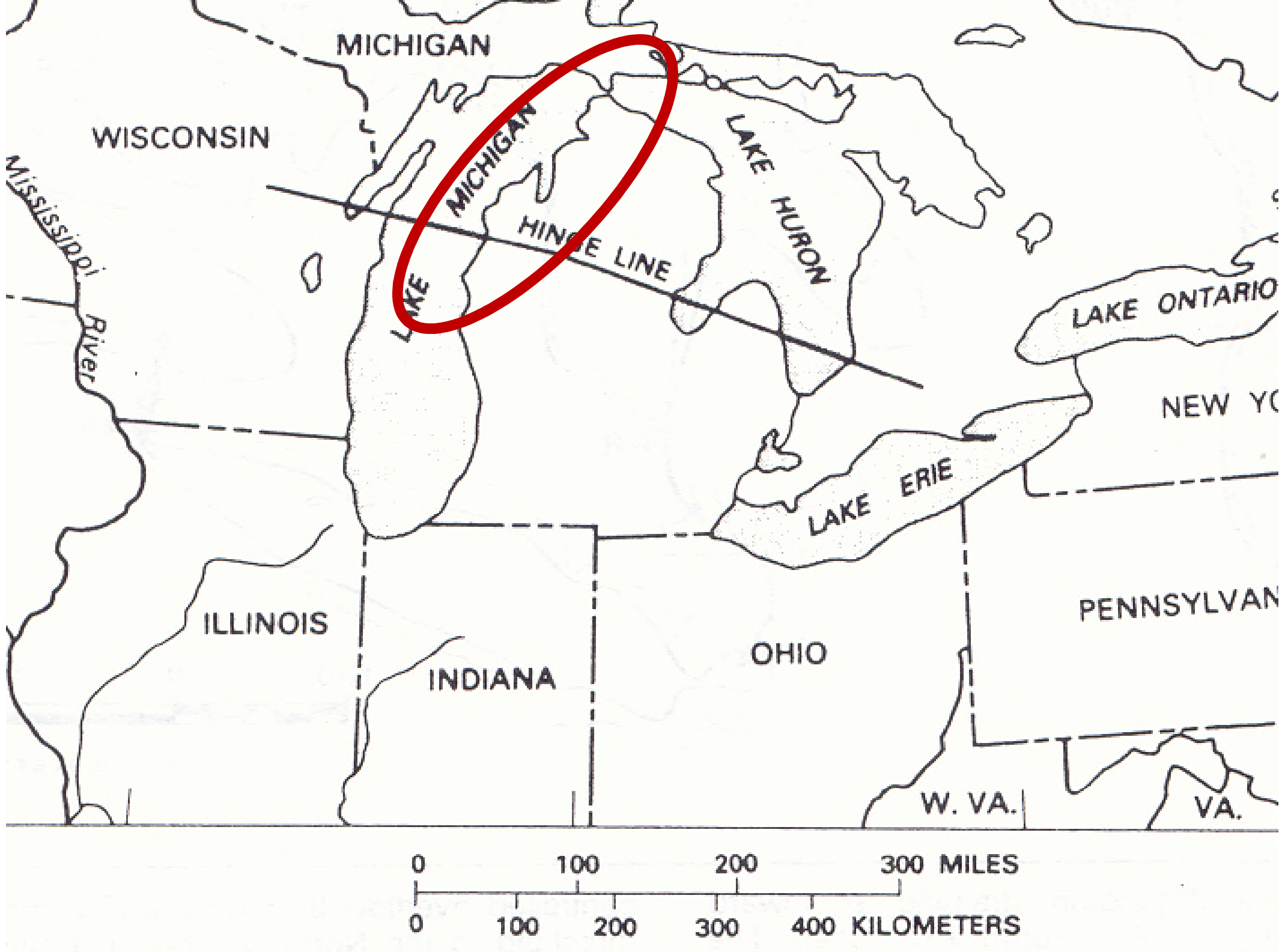
Van Buren, 1999



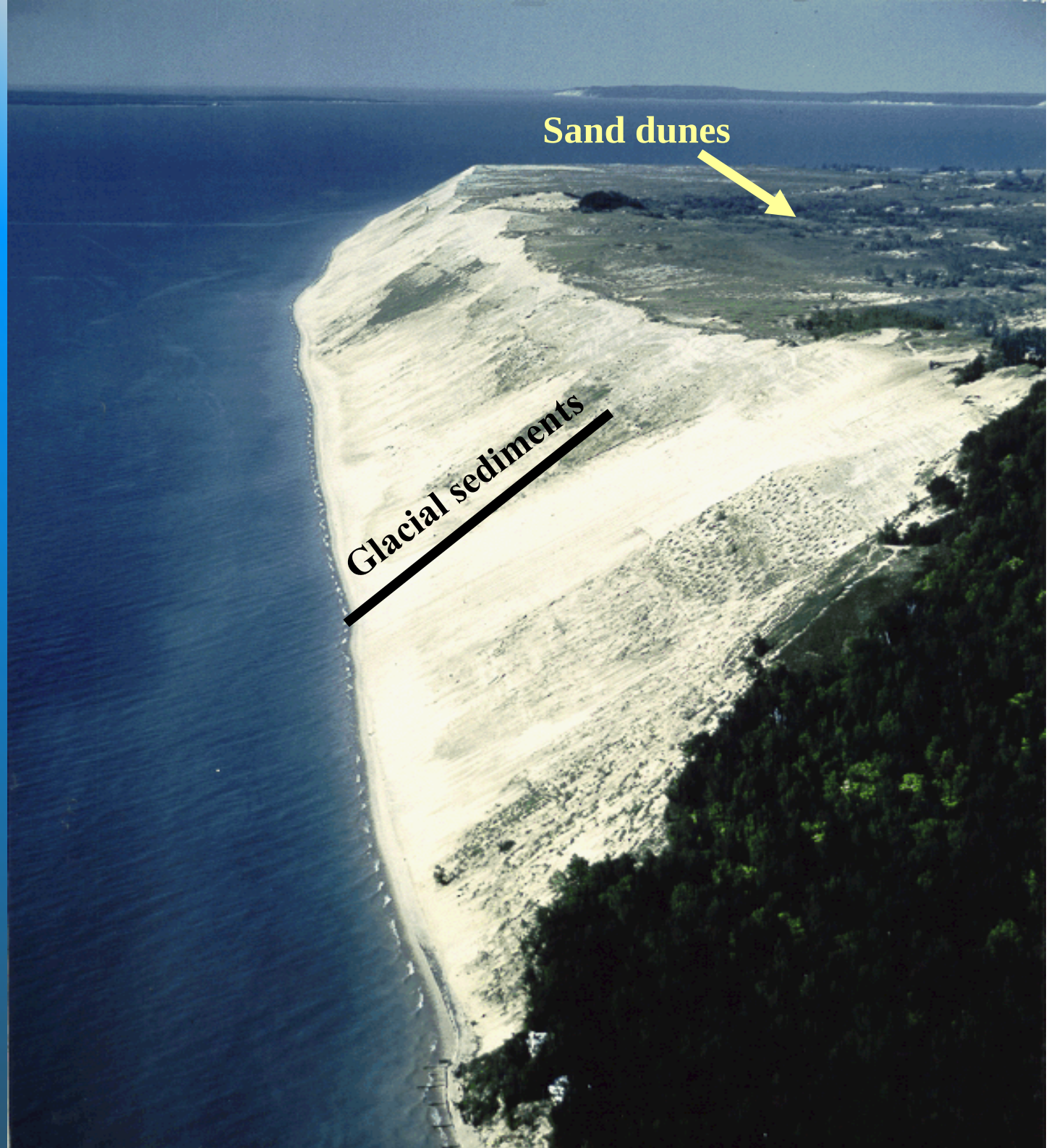
Most dunes contain 4 or 5 Entisols like this one. This soil represents a brief period of landscape stability (i.e., no growth) as the dune evolved.

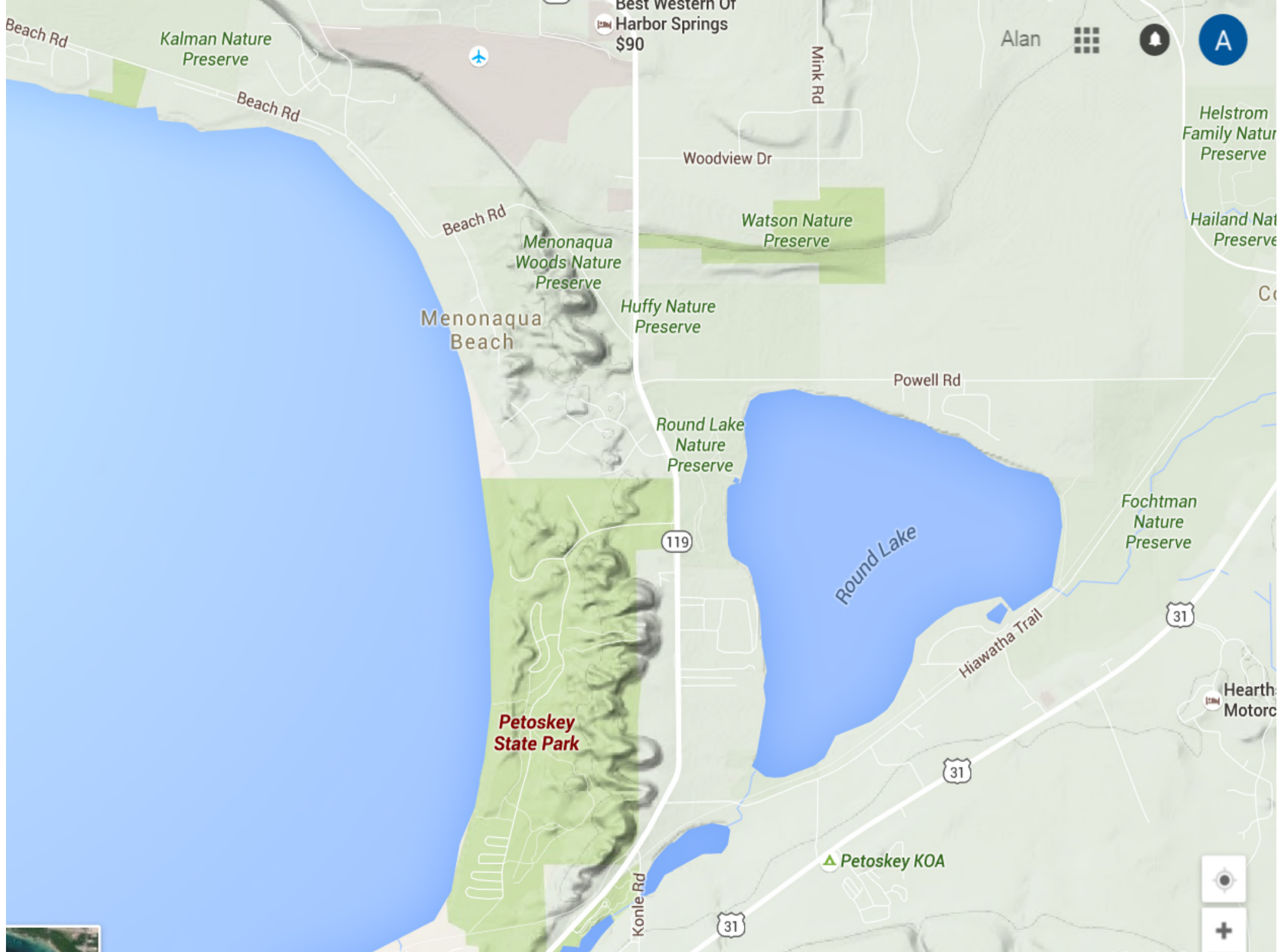


Most dunes also contain one relatively well developed soil with Spodic-like characteristics This soil is usually found in the upper part of the dunes andrepresents a relatively long period of landscape stability (i.e., no growth) as the dune evolved.

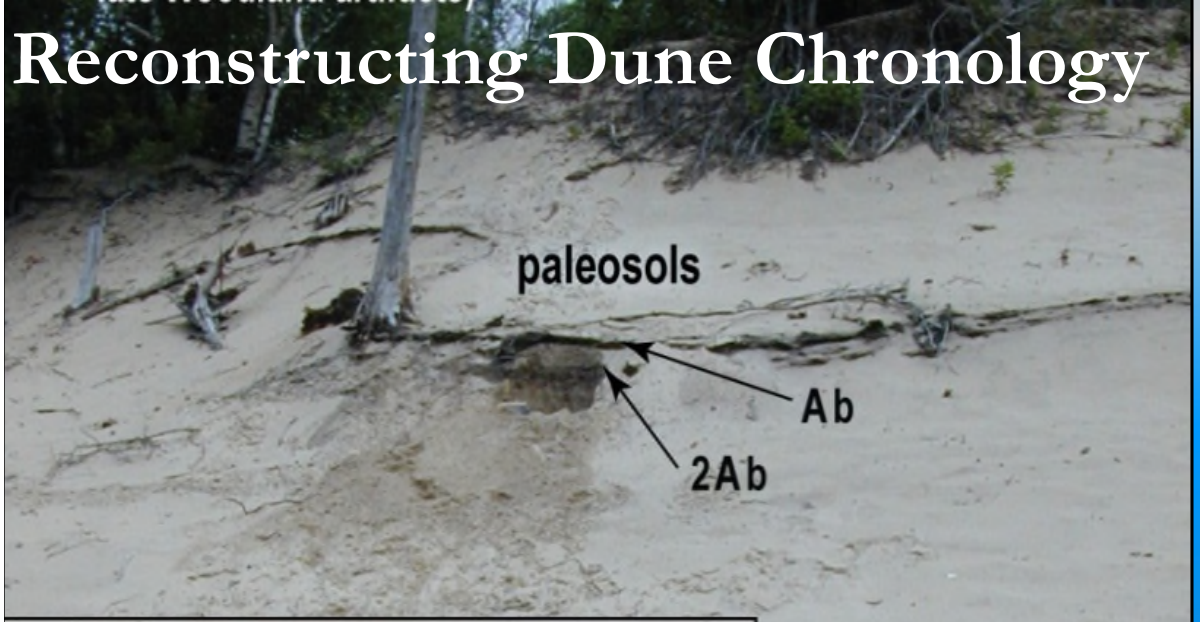

MICHIGAN
WISCONSIN
LAKE MICHIGAN
HINGE LINE
LAKE HURON
LAKE ONTARIO
NEW YO
Mississippi River
LAKE ERIE
PENNSYLVAN
ILLINOIS
INDIANA
OHIO
W. VA.
VA.
0 100 200 300 MILES
0 100 200 300 400 KILOMETERS

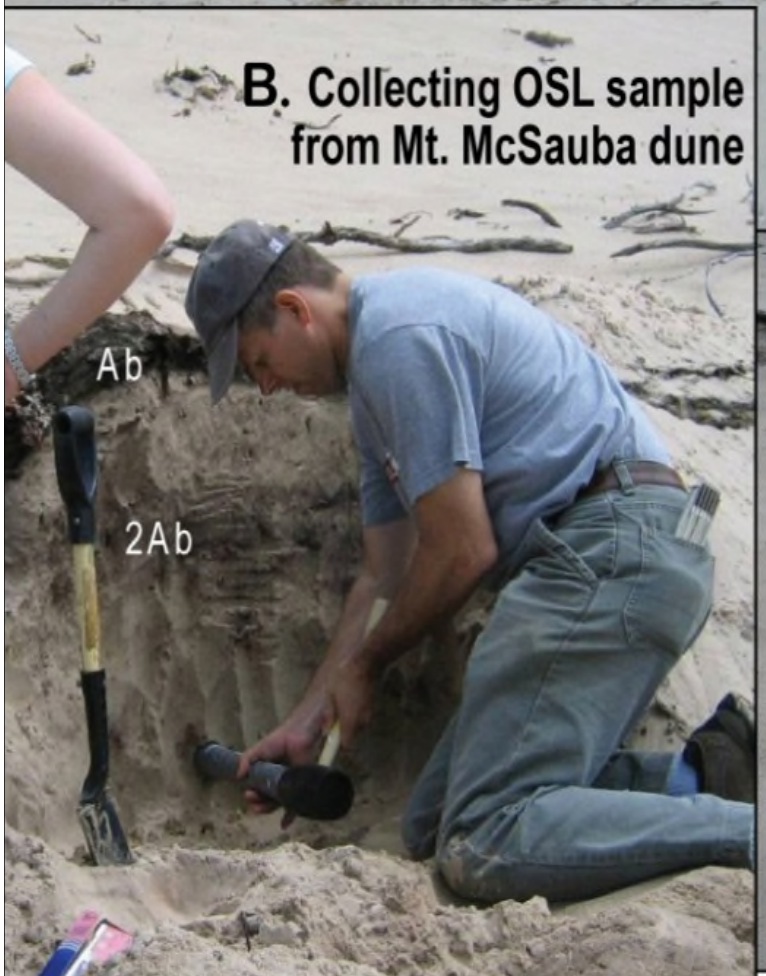
Sleeping Bear Dunes



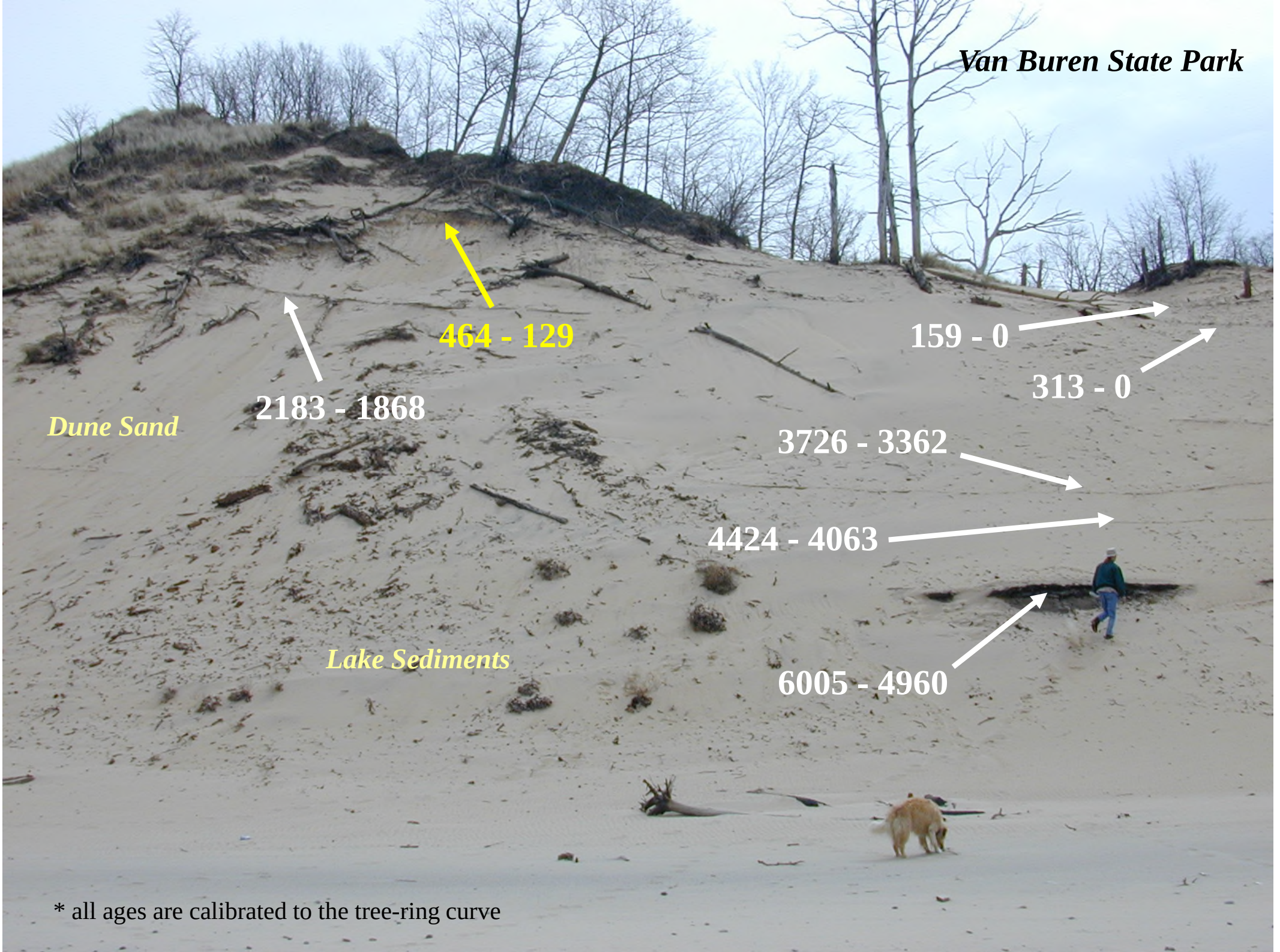

Beach Rd
Kalman Nature Preserve
Beach Rd
Best Western Of Harbor Springs $90
Mink Rd
Alan
A
Helstrom Family Natur Preserve
Woodview Dr
Beach Rd
Watson Nature Preserve
Hailand Nat Preserve
Menonaqua Woods Nature Preserve
Huffy Nature Preserve
Menonaqua Beach
Powell Rd
Round Lake Nature Preserve
Fochtman Nature Preserve
119
Round Lake
31
Hiawatha Trail
Petoskey State Park
31
Petoskey KOA
Konle Rd
31

Reconstructing Dune Chronology



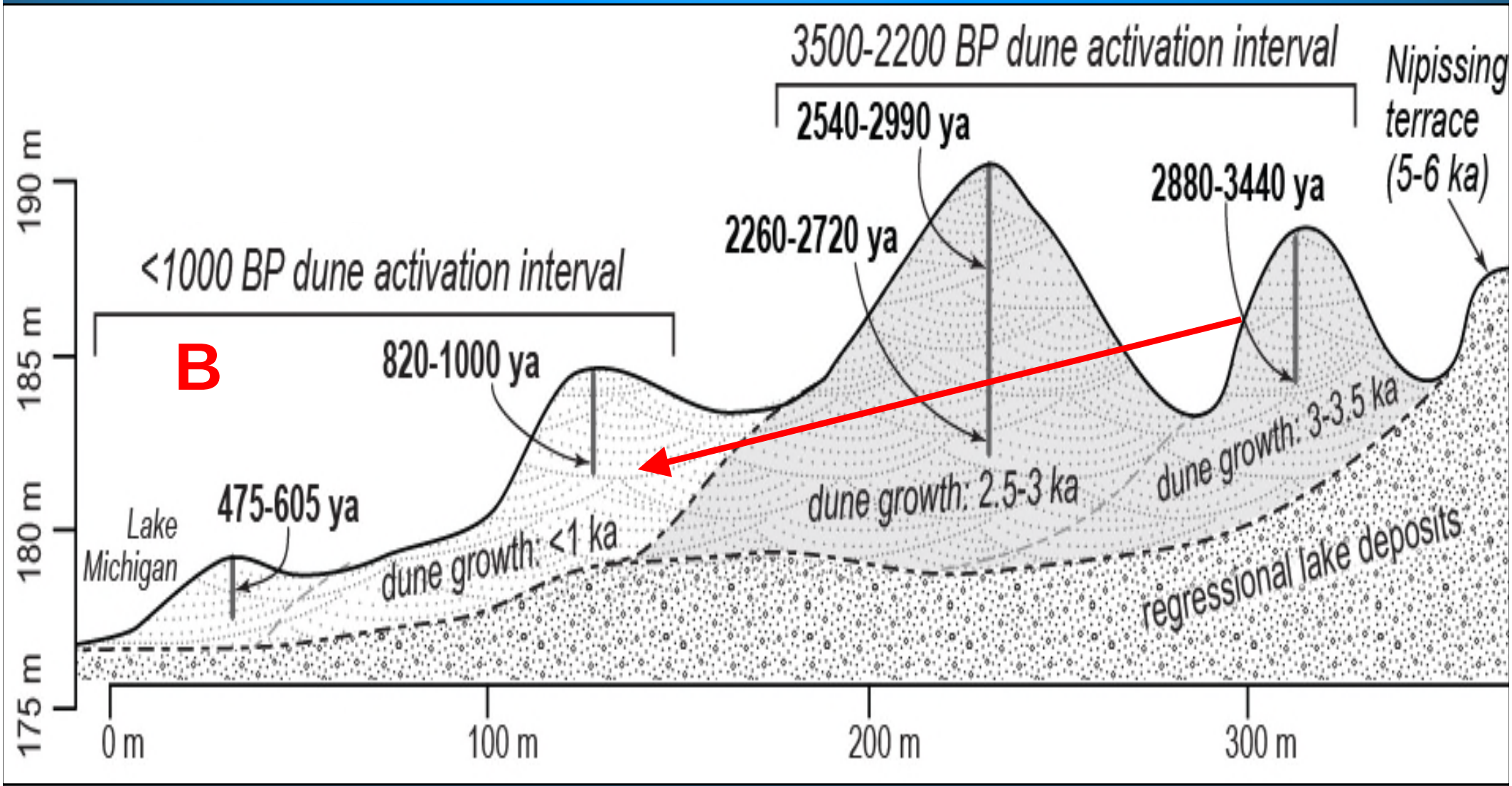


- **Radiocarbon** (C-14): soil organics
- **Optically Stimulated Luminescence** (OSL): burial age of sand in dunes

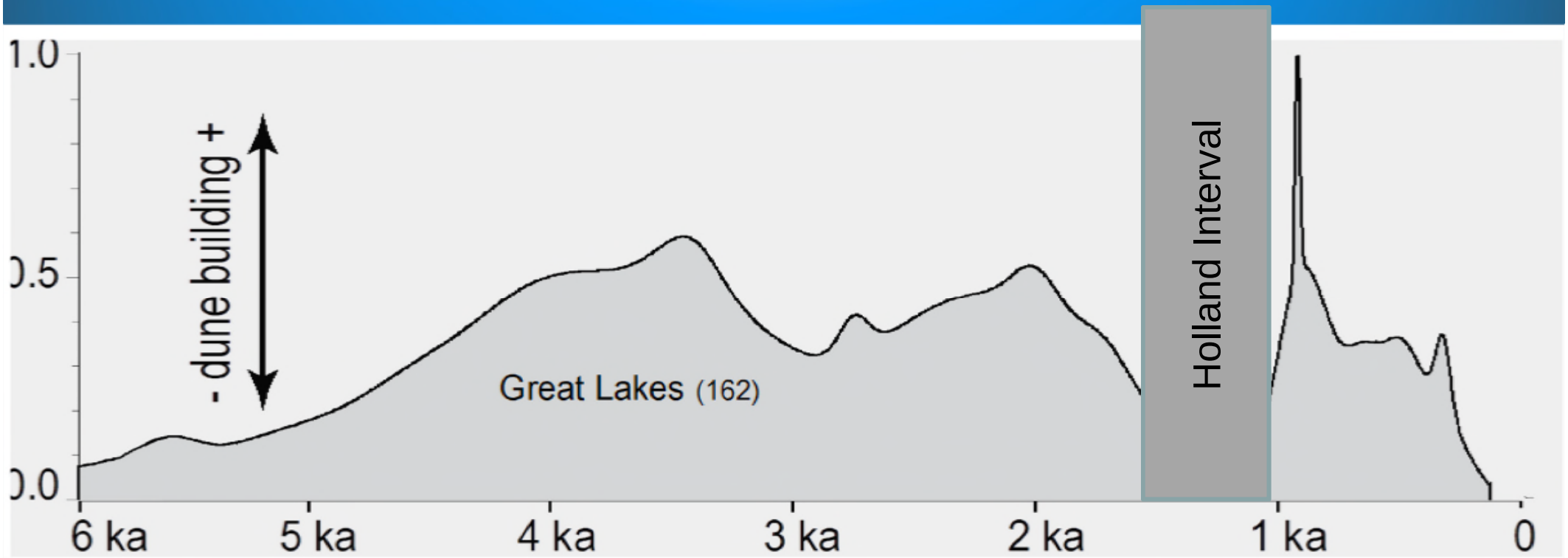


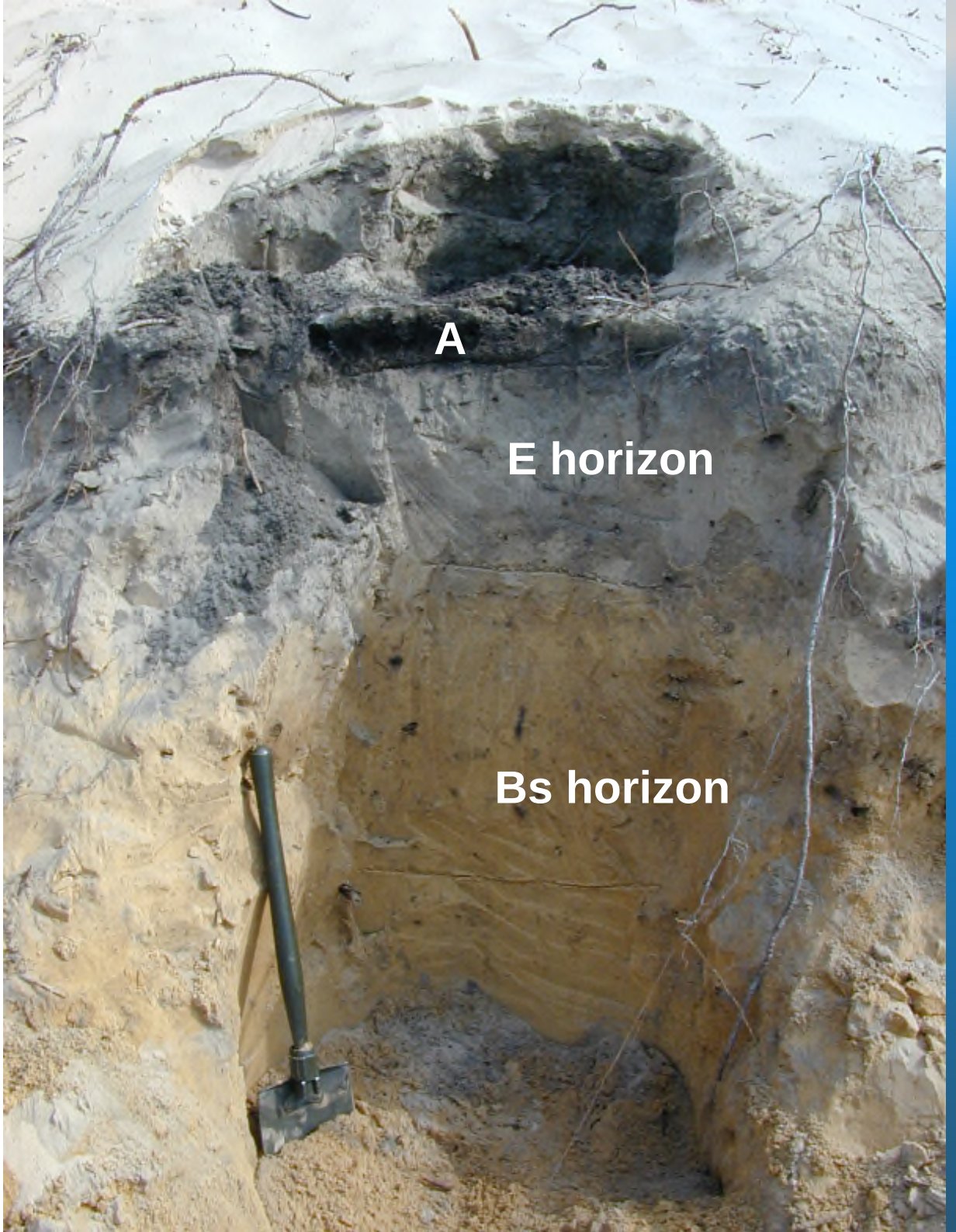
* all ages are calibrated to the tree-ring curve

Torch Bay Transect



PDD of OSL ages around Lake Michigan





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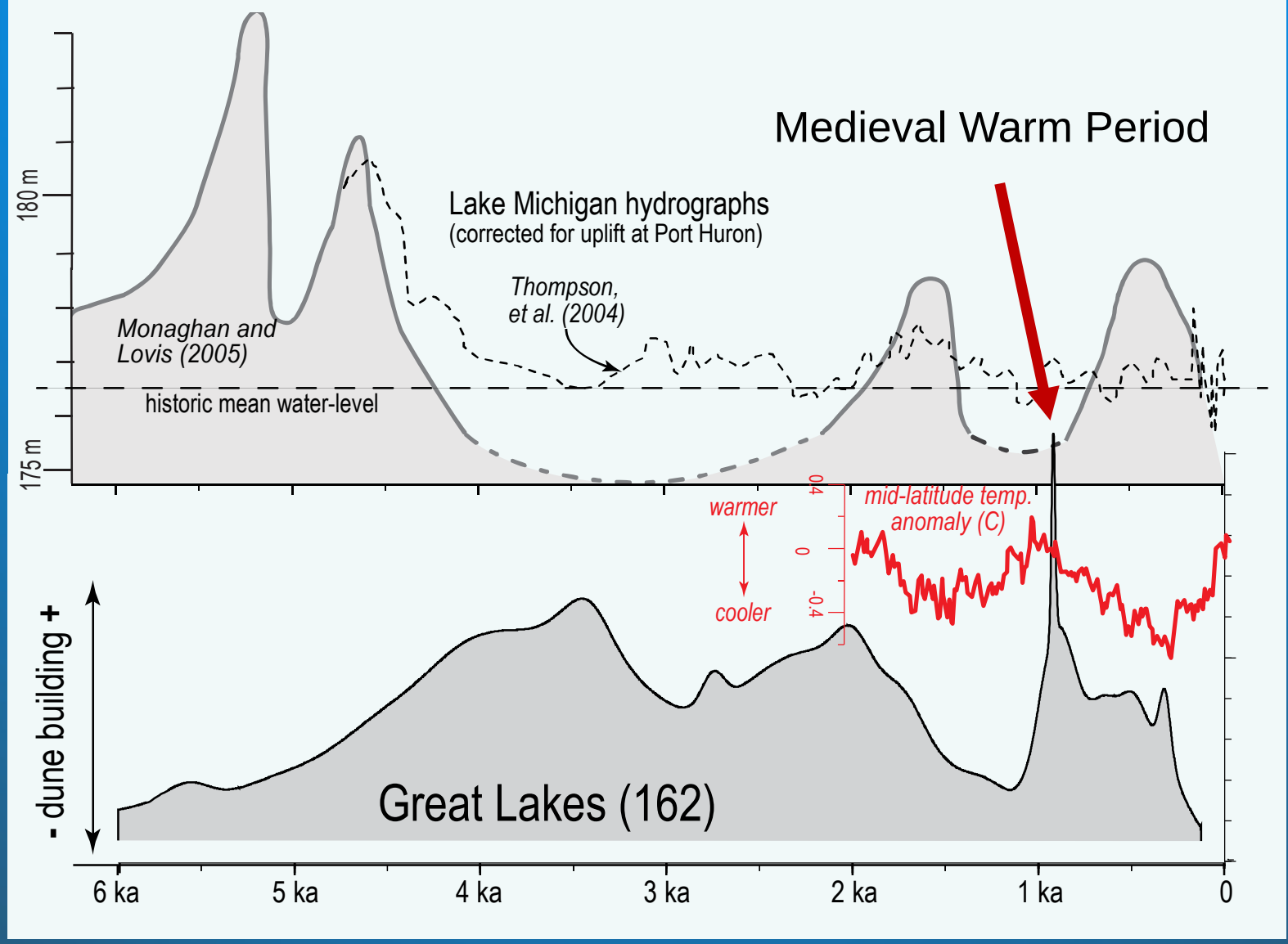
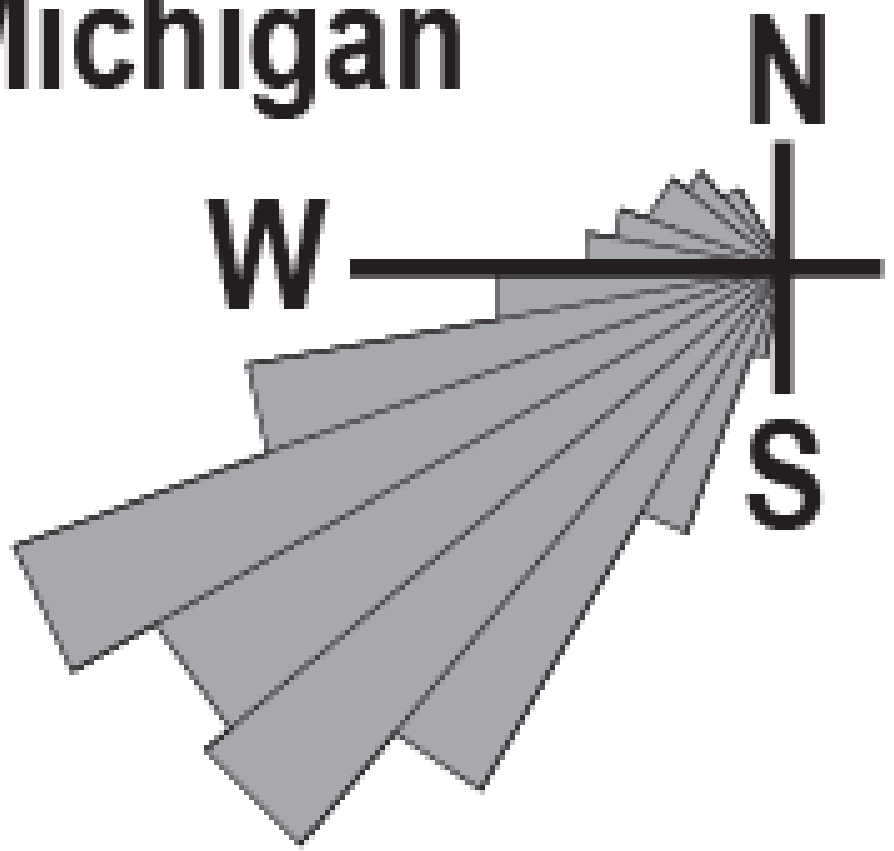
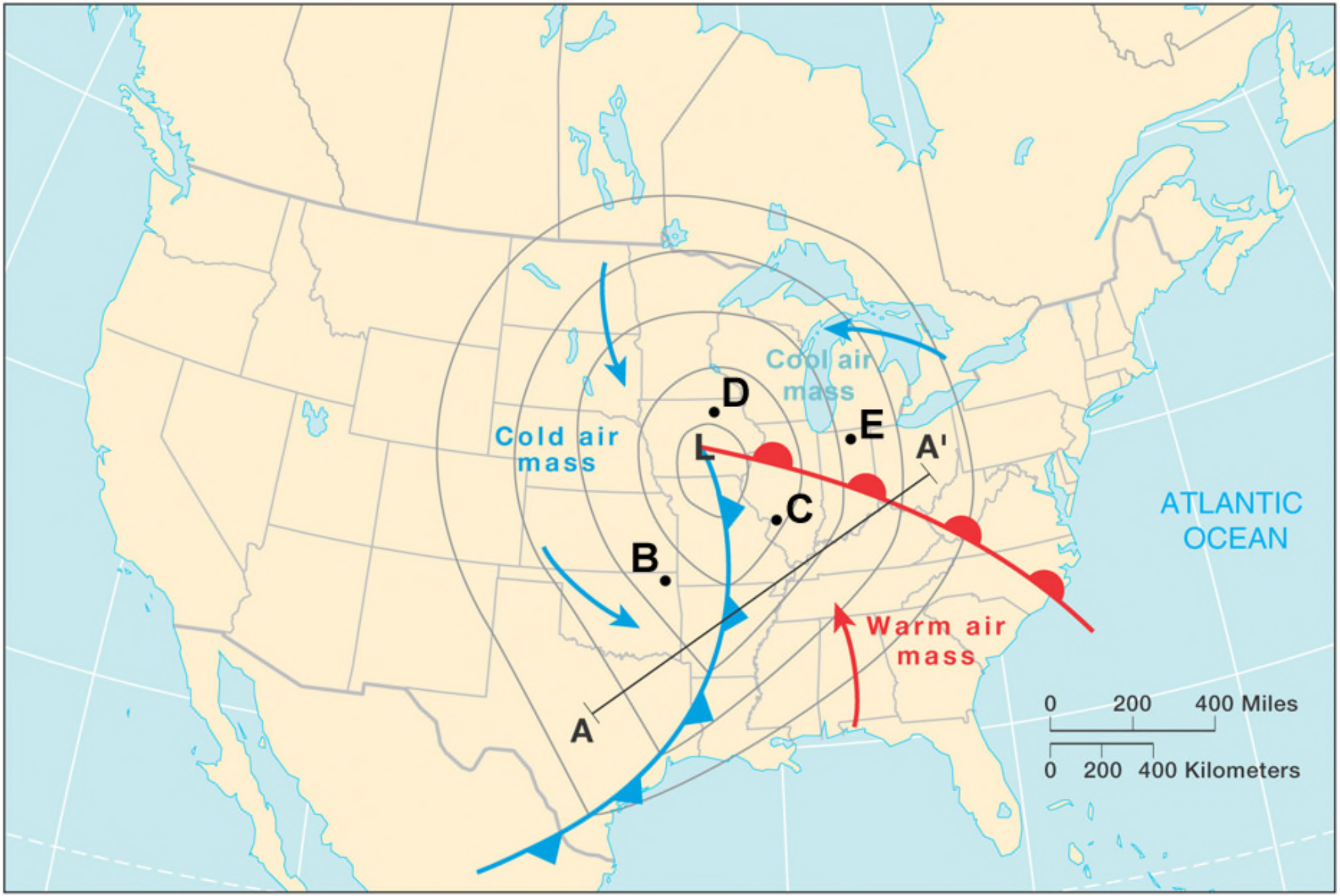


1) Dunes appear to have grown mostly (5x) during transgressive events (but not always)

2) Dunes stabilized when lake levels subsequently fell.

wind direction for the formation of 1,213 parabolic coastal dunes, L. Michigan




Cool air mass
Cold air mass
D
E
L
A'
C
B
A
ATLANTIC OCEAN
Warm air mass
0 200 400 Miles
0 200 400 Kilometers

What Does the Very Recent Past Tell Us?

Note: All of these numbers are the average of 6 gages in Lake Michigan and Huron.

LAKE MICHIGAN LAKE LEVEL 1996 - 2014

Monthly Averages Plotted

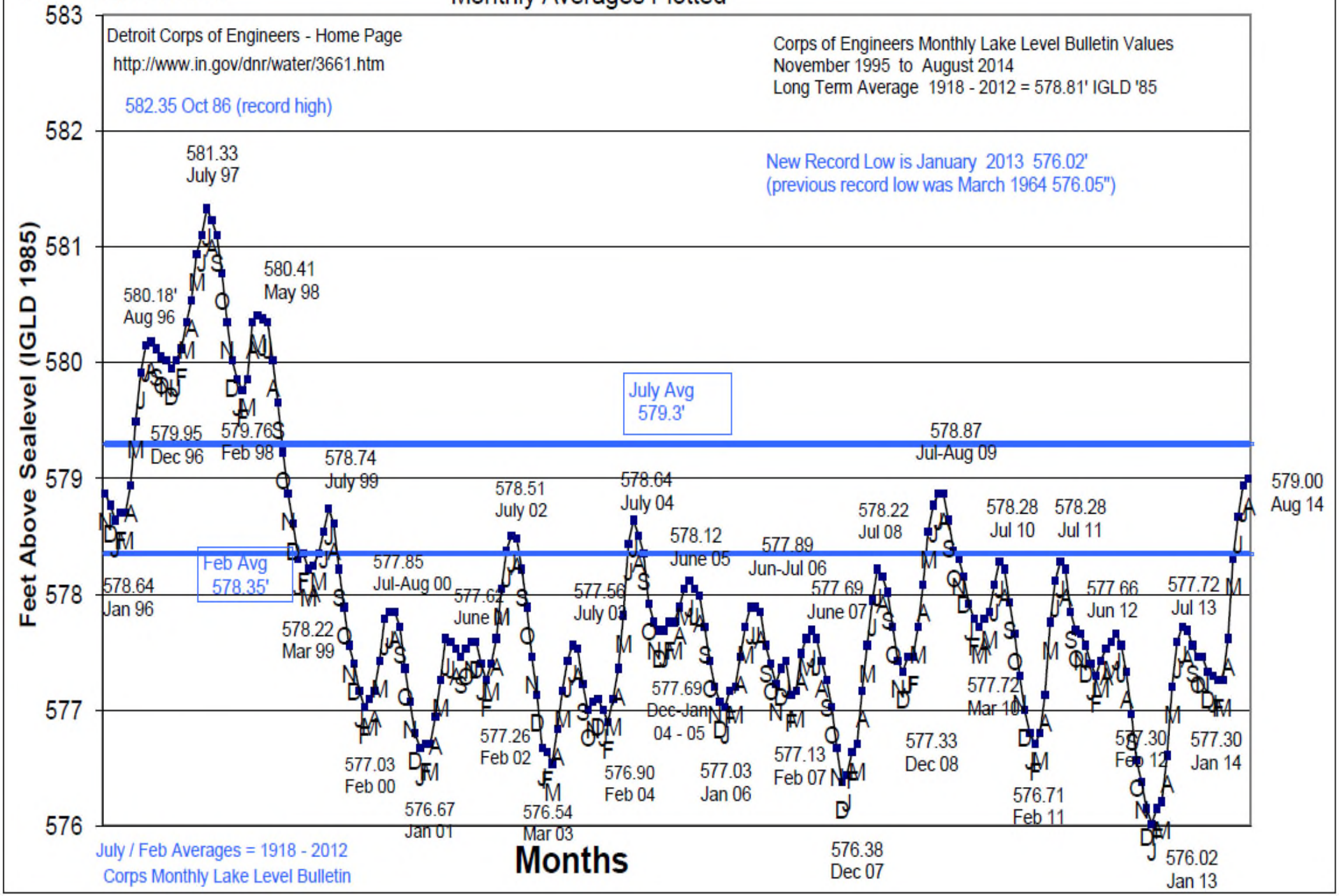


Photo: Ed Hanson

Van Buren, 1999

Van Buren, 2008


Van Buren, 2014

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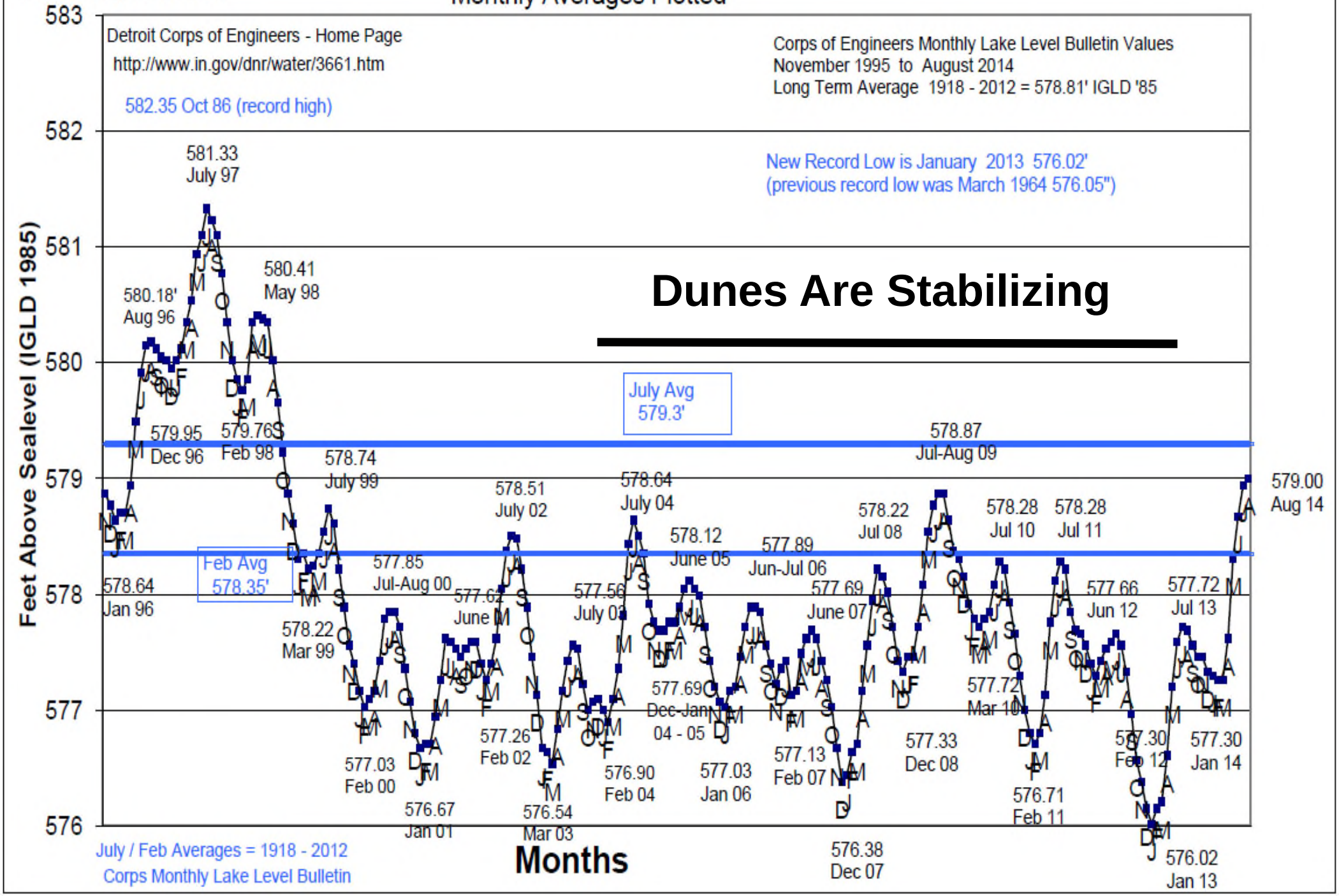
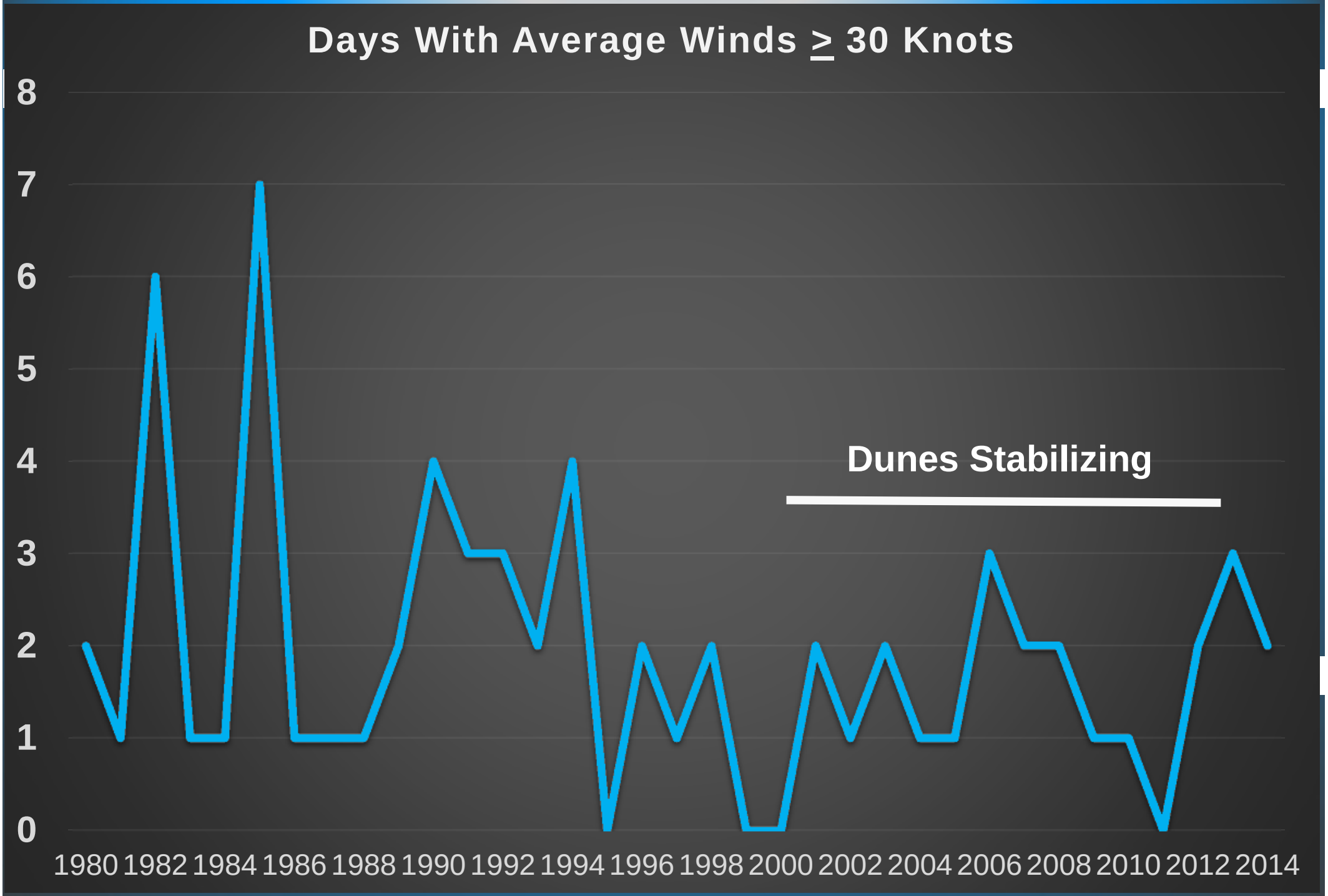




Source: State of Michigan Climate Center

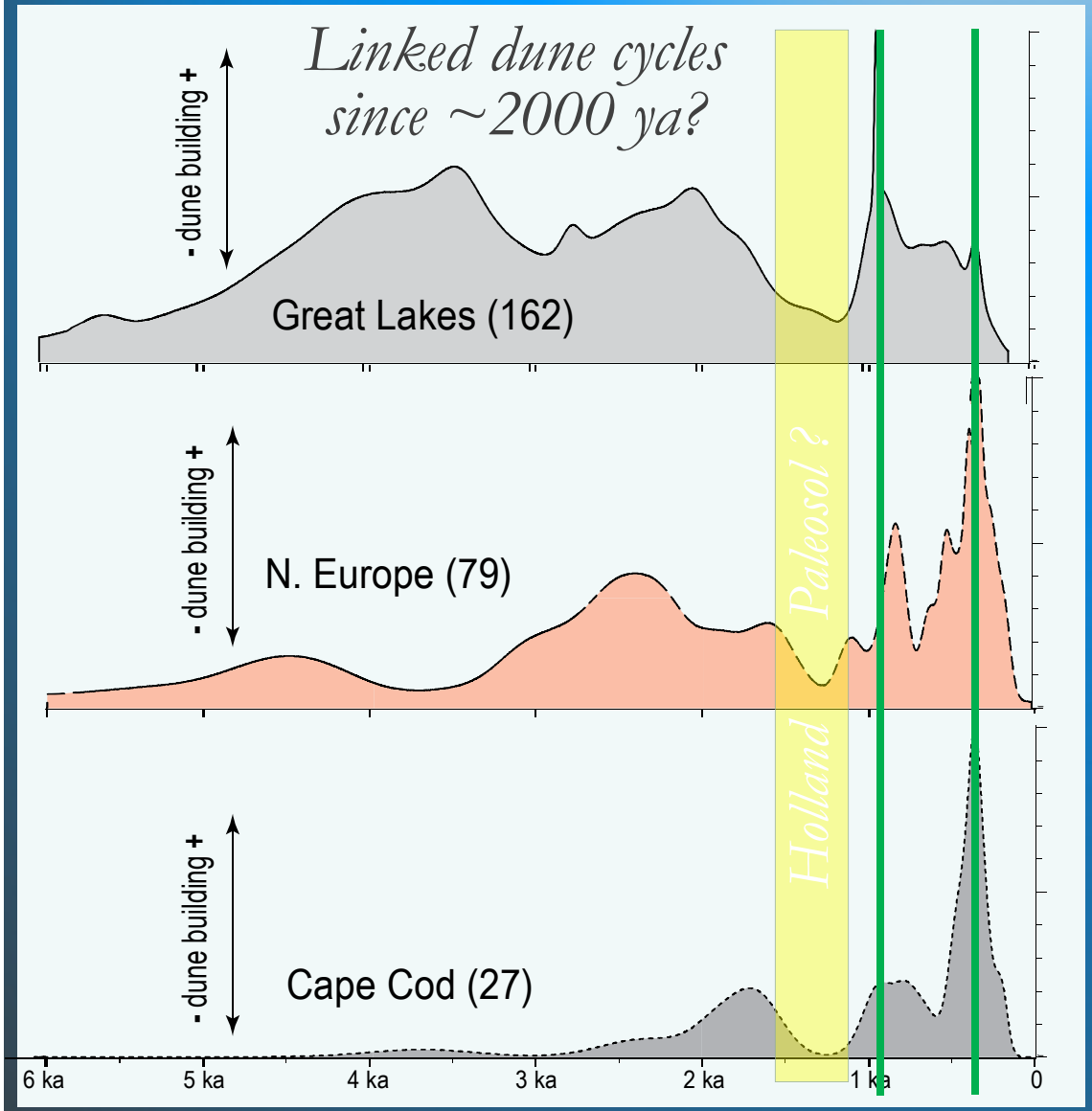
Questions:

1) What role do lake-level fluctuations play in dune evolution?

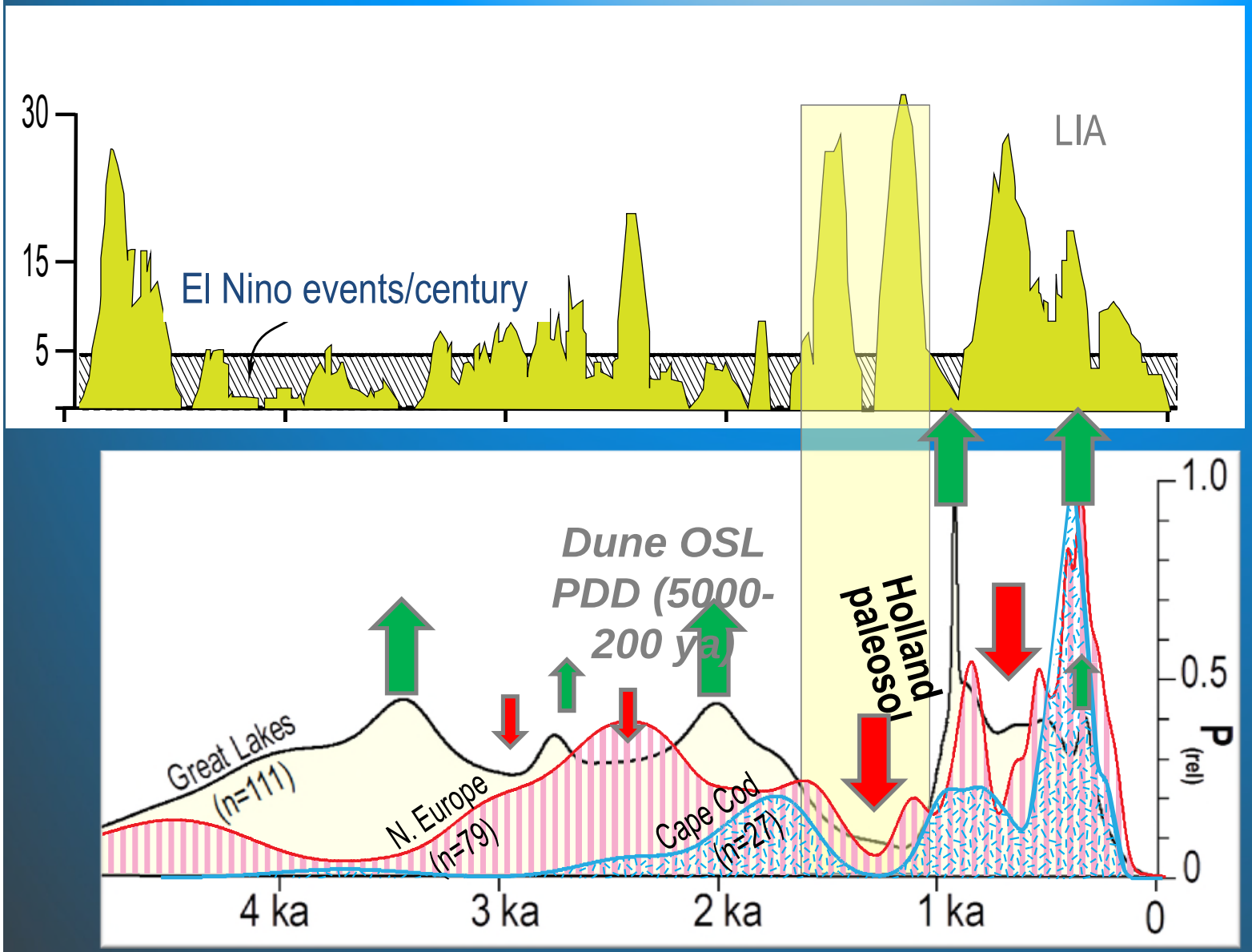
2) How do local site conditions influence dune evolution?

3) Storminess (strong winds) certainly plays a role,
but in what way?

Even Broader Linkages??



- What are the drivers and forcing variables that promote (basin-wide or world-wide) dune growth,
- Can we integrate the large-scale cycles & hemispheric teleconnections by comparing dune cycles from the mid-continent/northeast North America with northern European coastal dunes.

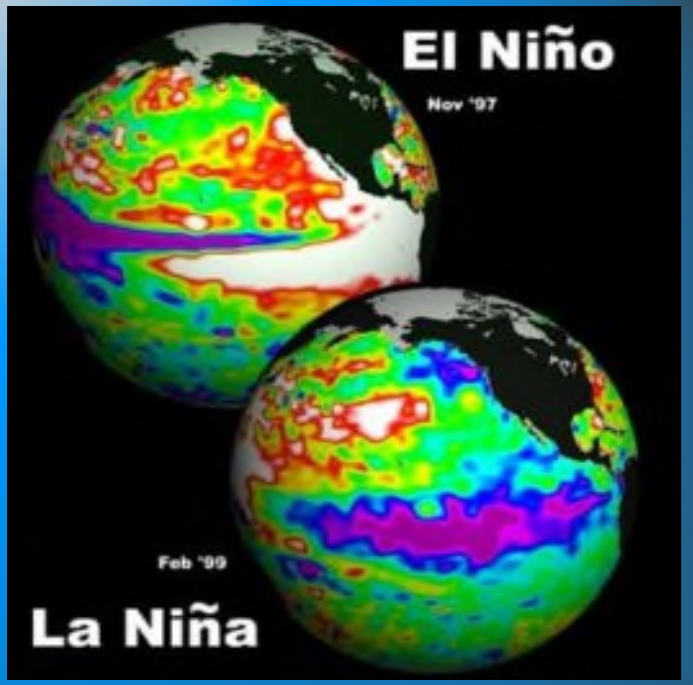


During the late Holocene, major hemispheric-scaled drivers apparently become connected across the atlantic and drive dune building in Europe and North America. While these are probably related to ENSO, NAO, PNA, etc. the ***why and how*** remain unclear

The El Niño-Southern Oscillation (ENSO)

describes fluctuating ocean temperatures in equatorial Pacific. Warmer waters oscillate back and forth across the Pacific, controlling North American (and global) variations climate patterns because of wind (jet stream) flow patterns. Two main phases are:

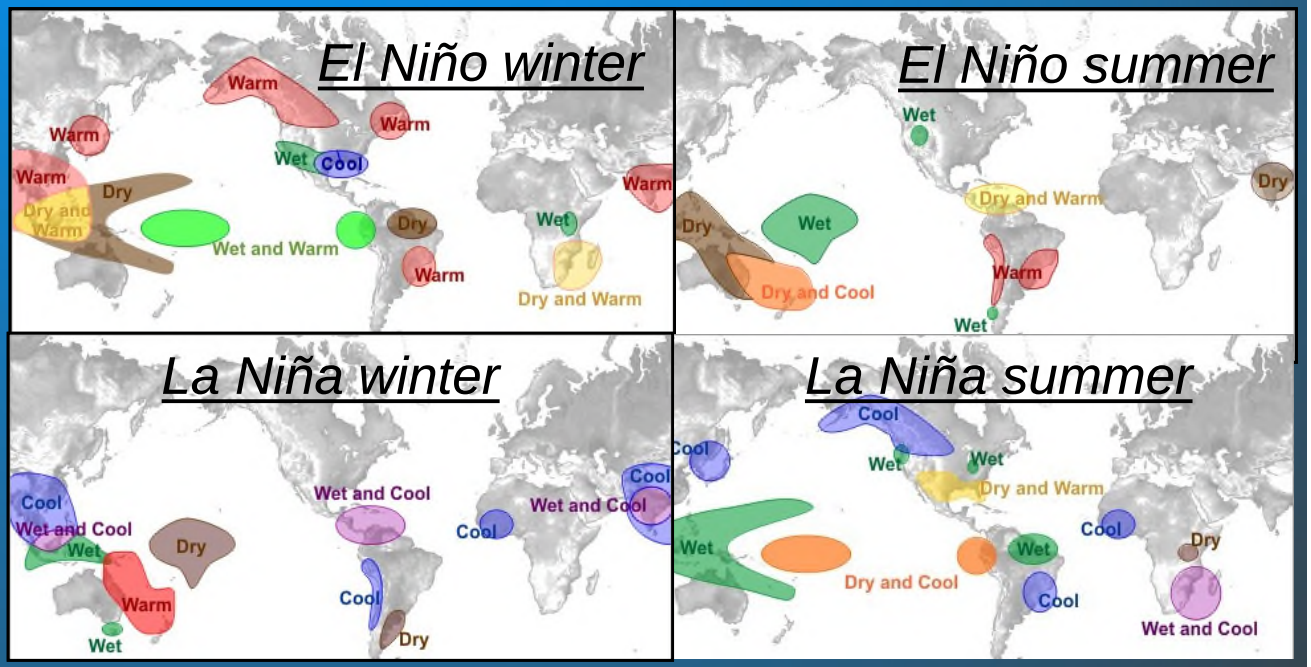
El Nino (warm pacific) and ***La Nina*** (cold pacific)

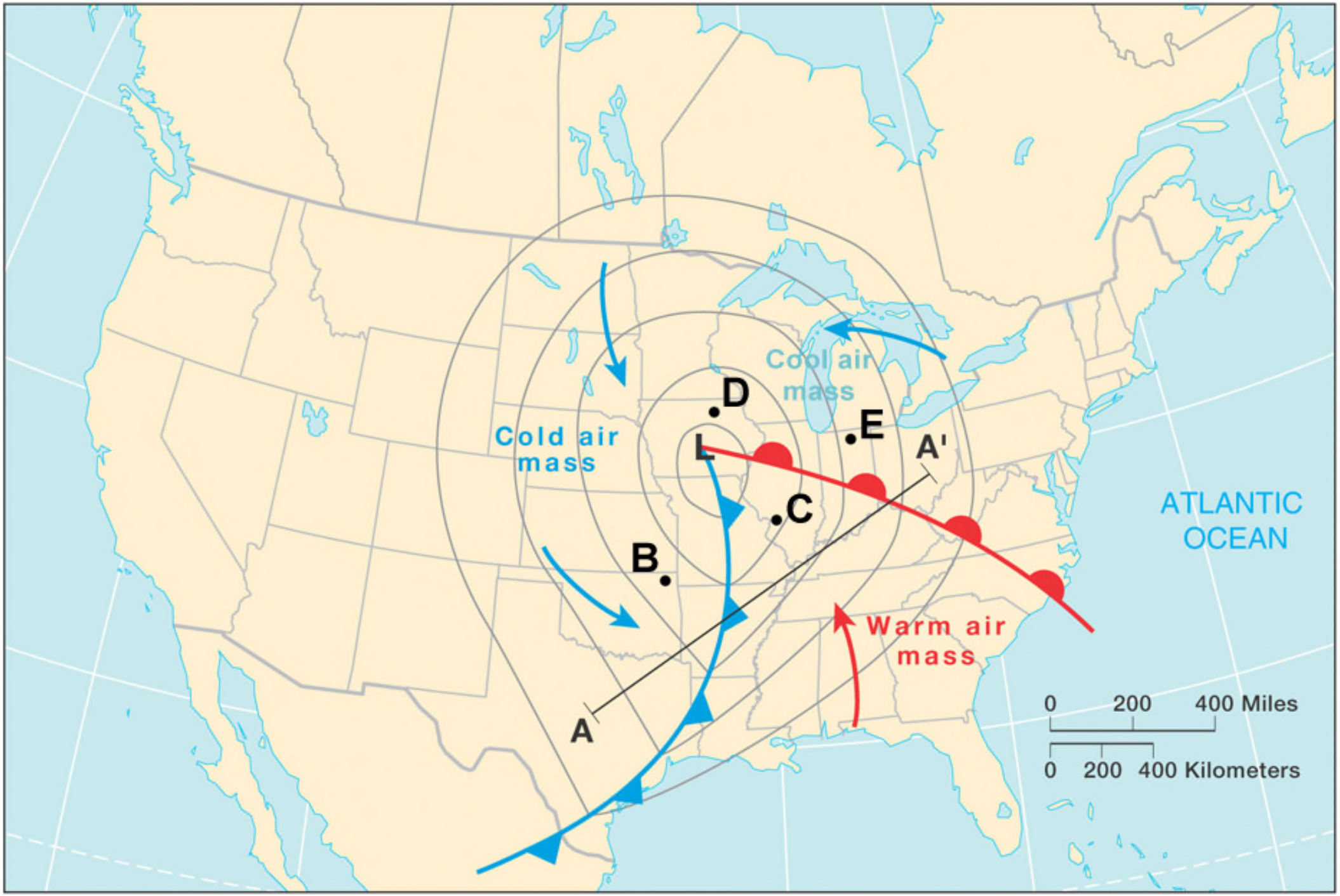


In the Great Lakes/Northeast:

El Nino are often characterized by mild and warm winters with fewer winter storms

La Nina are often characterized by colder winters and more common autumn and winter storms, particularly low pressure systems that originate in the SW USA and track into the Great Lakes region




Cool air mass
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D
E
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B
A
ATLANTIC OCEAN
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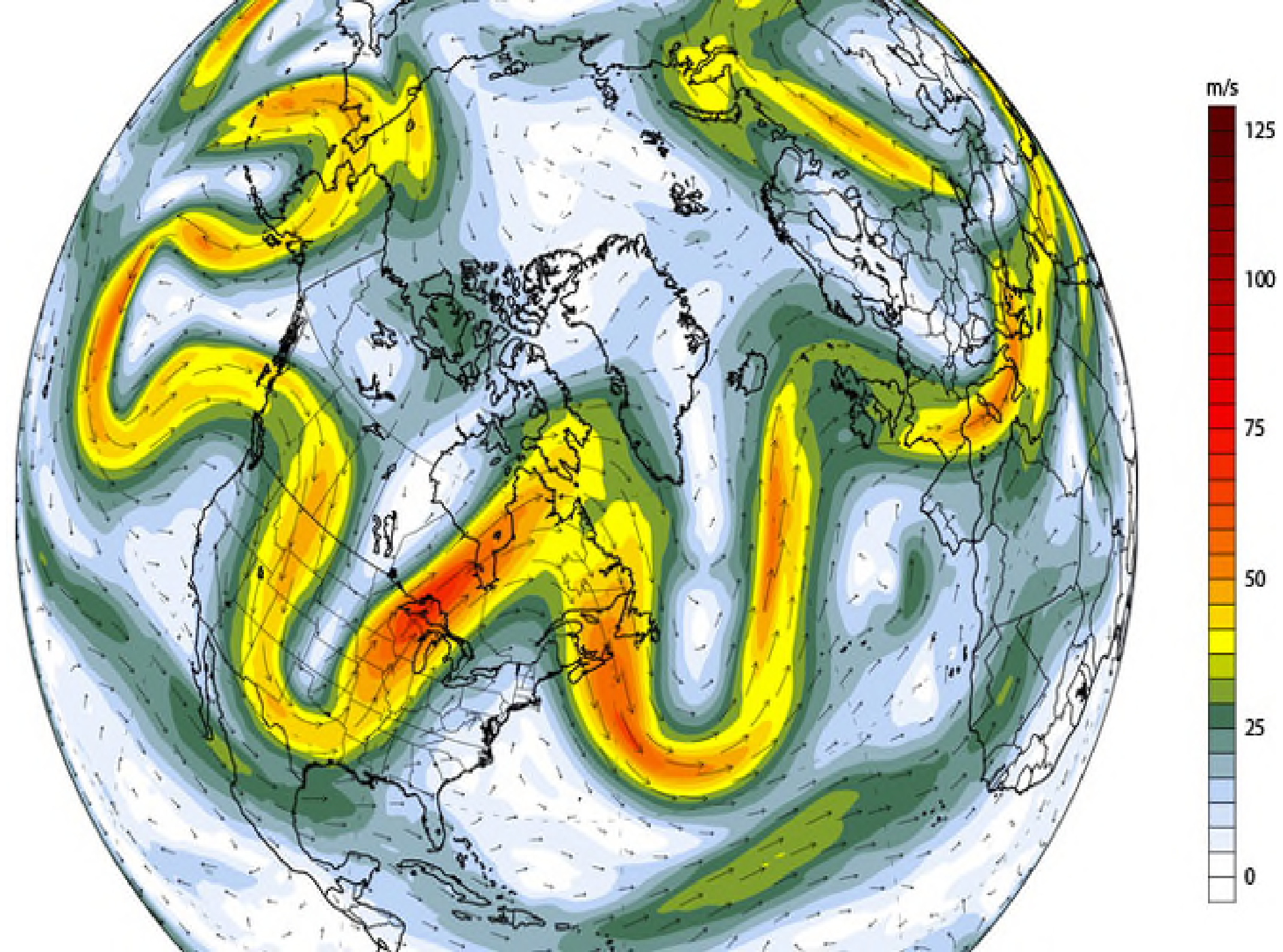
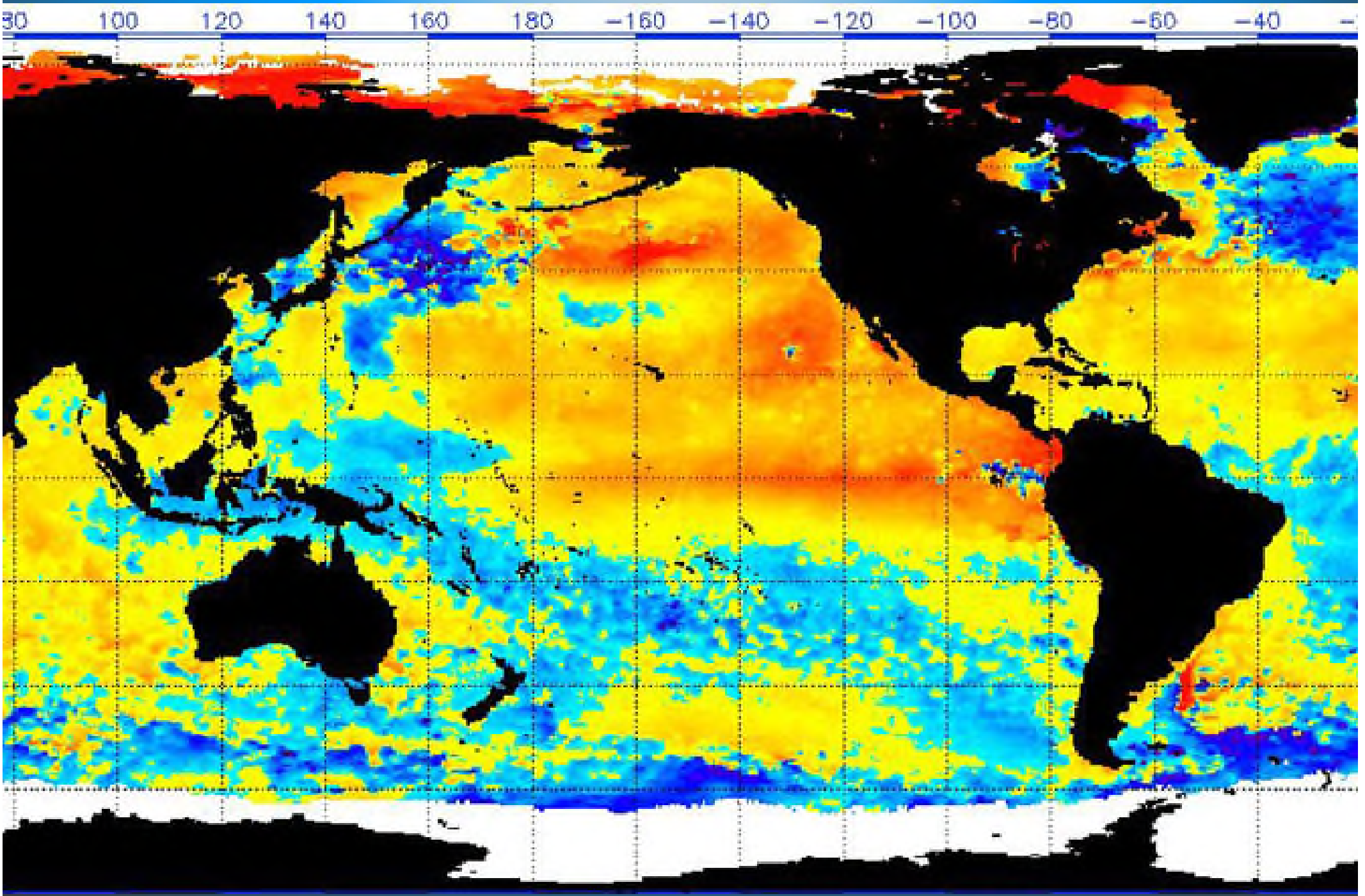

m/s
125
100
75
50
25
0

Current Conditions



El Niño in Pacific could mean mild Michigan winter

By Keith Matheny, Detroit Free Press 11:38 p.m. EDT September 12, 2015

(Photo: Mandi Wright, Detroit Free Press)

If Michiganders' teeth are still chattering from the record-cold, record-snow, record-ice winter of two years ago — and last winter's wallop -- relief may be on the way.

A weather phenomenon in the Pacific Ocean known as El Niño is as close to a certainty for this winter as weather forecasters typically go. And historically, that means a relatively warmer winter, with less precipitation in Michigan.

"Our models show there's a 95% chance El Niño will continue through the winter," said Tom Di Liberto, a meteorologist with the National Oceanic and Atmospheric Administration's Climate Prediction Center in College Park, Md.

& Less Stormy!

Acknowledgments

Antrim County Parks
Federal Highway Administration
Friends of Sleeping Bear Dunes National Lakeshore
Hiawatha National Forest
Indiana Geological Survey
Michigan Department of Environmental Quality
Michigan Department of Natural Resources
Michigan Department of Transportation
Michigan State University
National Science Foundation
Torch Bay Township

& Many Individual Property Owners


Thanks for Listening!